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Constrained inefficiency of competitive entrepreneurship☆

Sakai Ando *, Misaki Matsumura

International Monetary Fund, United States of America
Department of Economics, Columbia University in the City of New York, United States of America

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ABSTRACT

We study the constrained efficiency of a competitive entrepreneurship model that features the occupation choice between entrepreneurs and workers. It is shown that, even when (1) the only friction is uninsurable entrepreneurial risks and (2) agents are risk-averse, the competitive market can generate too many entrepreneurs. We present a sufficient statistic that determines the constrained inefficiency and its direction (whether market generates too many entrepreneurs or too few) by exploiting the unique feature of the model where the equilibrium is characterized by an indifference condition instead of a marginal condition. The framework is also pedagogically useful to understand constrained efficiency analysis at intuitive level.

1. Introduction

Competitive entrepreneurship models that feature the occupation choice between entrepreneurs and workers have been used extensively in the literature. Lucas (1978), Kanbur (1979a,b, 1982), Kihlstrom and Laffont (1979), Gine and Townsend (2004), Cagetti and De Nardi (2006, 2009), Vereshchagina and Hopenhayn (2009), Buera et al. (2011), Buera and Shin (2013) and Garicano et al. (2016) Despite the popularity, its constrained efficiency has not been analyzed systematically. In this paper, we characterize the constrained efficiency and present a sufficient statistic that determines constrained inefficiency and its direction.

The key feature of the competitive entrepreneurship models is the individual occupation choice. To present the essence of the argument, the baseline model is kept parsimonious and divided into two stages. In the first stage, ex-ante identical agents choose to become either entrepreneurs or workers. Becoming entrepreneurs incurs entrepreneurial risks in the sense that (1) agents are not sure about their entrepreneurial productivity but sure about wage as of occupation choice and (2) there is no insurance market for such risks. In the second stage, uncertainty resolves and entrepreneurs with heterogeneous productivity hire the profit-maximizing number of workers. In equilibrium, the wage clears the labor market. Mathematically, the occupation choice is a binary decision, so the equilibrium condition is an indifference condition instead of a marginal condition.

The efficiency of the occupation choice is studied by defining a constrained planner who can intervene in the first stage but cannot in the second stage. Specifically, the constrained planner maximizes the ex-ante utility by choosing the number of entrepreneurs subject to the same second stage equilibrium conditions as the market equilibrium. In this setup, we study the constrained efficiency of competitive entrepreneurship by comparing the number of entrepreneurs chosen by the planner and the market. The main results of the paper are two folds. The first result is that the competitive market can generate *excessive* entrepreneurs even when (1) the only friction is uninsurable entrepreneurial risks and (2) agents are risk-averse. For completeness, we also characterize a class of economic fundamentals with which the competitive market generates *insufficient* entrepreneurs if and only if there are uninsurable entrepreneurial risks. The second result is that the intuition of constrained inefficiency and its direction can be reduced to a single sufficient statistic. Specifically, we show that the marginal risk premium of becoming an entrepreneur evaluated at the market equilibrium wage is a sufficient statistic to determine whether the market generates the efficient number of entrepreneurs or not, and if not, whether too many or too few.

The intuition of constrained inefficiency can be made transparent by highlighting the indifference condition. Specifically, at the market equilibrium, the wage makes sure that the certainty equivalents of the two occupations are equated, which implies that the marginal utilities of the certainty equivalents

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* Corresponding author.
E-mail addresses: sando@imf.org (S. Ando), mm4387@columbia.edu (M. Matsumura).

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are also equated. Thus, whether the planner's marginal intervention improves welfare or not can be reduced to the net gain in the certainty equivalents. Now, the planner's intervention that changes the number of entrepreneurs affects the wage through labor market clearing, and therefore, triggers redistribution of certainty equivalents between occupations. When there are no entrepreneurial risks, certainty equivalents and consumption are the same, so the marginal redistribution does not generate a net gain. However, when there are entrepreneurial risks, the marginal redistribution through wage between the two jobs with different riskiness can have different impacts on the certainty equivalents of the two groups. When they differ, the planner can find a welfare-improving intervention, and thus, the market equilibrium is constrained inefficient.

For the direction of the constrained inefficiency, what matters is the sign of the net gain in the certainty equivalents. We show that the sign is determined by the relative importance of (1) the riskiness of the income and (2) the risk attitude of the agents. Intuitively, the market generates too many entrepreneurs if the risk aversion of entrepreneurs decreases sharply as their income increases. In this situation, if the number of entrepreneurs decreases and workers increases, the additional labor supply suppresses wage so the income of entrepreneurs increases. The resulting reduction of risk premium leads to higher ex-ante welfare.

Our paper belongs to the literature of the constrained efficiency analysis pioneered by Diamond (1967). Our result shares the same flavor as the generic constrained inefficiency of incomplete markets. Geanakoplos and Polemarchakis (1986), Greenwald and Stiglitz (1986) and Geanakoplos et al. (1990) However, the model we study is not covered in their framework and we exploit the specific model structure of occupation choice to characterize not only constrained inefficiency but also its direction and a sufficient statistic behind them. In this sense, our paper belongs to the group of papers that study the constrained efficiency of a particular model by leveraging the model specific structures, such as Farhi et al. (2009), Davila et al. (2012), Toda (2015) and Gottardi et al. (2016) that study the constrained efficiency of Diamond and Dybvig (1983), Aiyagari (1994) and Krebs (2003). Compared to these papers, our paper is unique in its pedagogical value since the indifference condition makes the logic of constrained efficiency analysis more transparent than usual marginal conditions. The occupation choice model itself goes back to Lucas (1978), Kanbur (1979b,a) and Kanbur (1982). The difference from Kanbur (1981) and Kihlstrom and Laffont (1979) is that they study the inefficiency of the combination of both entrepreneurial risks and ex-ante labor decision, while we disentangle the implication specific to entrepreneurial risks.

2. Competitive entrepreneurship model

This section describes the competitive entrepreneurship model. We define and characterize the equilibrium.

There is a continuum of ex-ante identical risk-averse agents of mass 1. Each agent is endowed with 1 unit of labor that can be spent in running a firm or working for a firm.

If she chooses to be an entrepreneur, she observes her entrepreneurial productivity z which is independently and identically distributed according to a cumulative distribution function G. Then, given wage w, she decides the number of employees n to maximize the profit

$$[\pi(z,w), n(z,w)] = \max_{n\geq 0} zf(n) - wn. \tag{1}$$

The notation indicates that π and n are the value and policy functions of the maximization problem on the right-hand side.

If she chooses to become a worker, she receives wage w independent of her entrepreneurial productivity z. Given the payoffs of the two occupations, each agent chooses the occupation that maximizes her welfare

$$\phi = \arg\max_{e\in[0,1]} e\mathbb{E}[u(\pi(z,w))] + (1-e)u(w), \tag{2}$$

where u is the utility function and the expectation is taken with respect to the productivity z.

We note three observations. First, the occupation choice is risky since agents do not observe their entrepreneurial productivity as of the occupation choice in the first stage. One exception is when the random variable z is degenerate, in which case there are no risks. Second, the choice variable e, representing whether to become an entrepreneur or not, can take a continuous value $e \in [0, 1]$. This formulation allows agents to take mixed strategies. As a result, we can focus on the symmetric equilibrium where all agents take the same strategy $\phi \in [0, 1]$. Conveniently, ϕ also represents the mass of entrepreneurs as the fraction of the total population 1. Third, since the market is competitive, agents' occupation choices do not internalize their impact on the wage. In anticipation, this feature will be the source of constrained inefficiency.

The model is closed by the labor market clearing condition

$$\phi\mathbb{E}n(z,w) = 1-\phi, \tag{3}$$

where the left-hand side is the labor demand and the right-hand side denotes the labor supply.

In summary, the market equilibrium is defined as follows.

Definition 1. Fix a set of fundamentals (u, f, G). (π, n, ϕ, w) is a market equilibrium if the following three conditions are satisfied.

(i) Given w, ϕ solves Eq. (2).

(ii) Given w, (π, n) solves Eq. (1).

(iii) The labor market clears Eq. (3).

The market equilibrium wage w^m makes sure that the two occupations are indifferent in equilibrium

$$\mathbb{E}u\left(\pi\left(z, w^m\right)\right) = u\left(w^m\right). \tag{4}$$

In other words, the market makes sure that the certainty equivalents of the two occupations are equal. These certainty equivalents are the key concepts to understand the constrained efficiency as discussed in the next section.

The pair of market equilibrium wage and number of entrepreneurs (w^m, ϕ^m) is then characterized by Eqs. (3) and (4). Thus, the wage is determined by Eq. (4) alone and the number of entrepreneurs is determined to clear the market. It is straightforward to establish existence and uniqueness.

Proposition 1. *Suppose (u, f) is continuously differentiable, strictly increasing, strictly concave, and satisfies the Inada condition. Then, there exists a unique equilibrium pair of wage and number of entrepreneurs $(w^m, \phi^m) \in \mathbb{R}_{++} \times (0, 1)$.*

Proof. See Appendix B. □

3. Constrained efficiency

This section defines the constrained efficient allocation and provides the main result. In the subsections, we describe the intuition of the constrained inefficiency and discuss the determinants of the direction of market failure.

The planner chooses occupations on behalf of agents, but the planner does not intervene in the production decisions. In other words, the planner does not have to satisfy the indifference condition (4) but has to respect the market clearing condition (3). One can interpret the planner either as the government that can control the supply of business license or simply as a theoretical device to understand the market failure associated with risky occupation choice.

We can formulate the planner's problem succinctly by using Eq. (3), which implicitly defines the price $w(\phi)$ as a function of the number of entrepreneurs.[1]

Definition 2. Fix a set of fundamentals (u, f, G). ϕ^{cp} is constrained efficient if

$$\phi^{cp} = \arg\max_{\phi\in[0,1]} U(\phi) := \phi\mathbb{E}u(\pi(z, w(\phi))) + (1-\phi)u(w(\phi)).$$

Note that we do not take any stance on the welfare criterion. This is because agents are ex-ante identical so that any Pareto weights lead to the same objective function. Establishing the existence and uniqueness for a general class of fundamentals is not easy, one reason being that the concavity of U requires the information of the third derivative of the production function f'''. However, Appendix C shows that, in the next proposition that presents the main result, both existence and uniqueness indeed hold.

The main result of the paper is that, given the above efficiency benchmark, the market equilibrium can feature insufficient or excessive entrepreneurs depending on the economic fundamentals.

Proposition 2. *Let ϕ^m be the market equilibrium number of entrepreneurs.*

1. There exists a set of fundamentals (u, f, G) such that (u, f) is continuously differentiable, strictly increasing, strictly concave, and satisfies the Inada condition but the resulting market equilibrium features excessive entrepreneurs $\phi^{cp} < \phi^m$.
2. Suppose the set of fundamentals (u, f) takes the form of constant relative risk aversion (CRRA) and Cobb–Douglas (CD). Then, the market generates insufficient entrepreneurs $\phi^m < \phi^{cp}$ if there are risks $V(z) > 0$. Otherwise $V(z) = 0$, the market is constrained efficient $\phi^m = \phi^{cp}$.

Proof. See Appendix C. □

The first statement might be surprising at the first sight because it says that the market can create too many entrepreneurs even when (1) the only friction in the model is the uninsurable idiosyncratic entrepreneurial risks and (2) agents are risk-averse. The result might sound less surprising if one realizes that the constrained planner does not have the power to remove the entrepreneurial risks, and therefore, the intuition is not as straightforward as entrepreneurship being insufficient because risks deter risk-averse agents from becoming entrepreneurs as described in the first best analysis in Appendix D.

Once the non-triviality of the intuition is recognized, the second statement should look surprising, because it says that the standard parametrization possesses some special characteristics that make the market-based entrepreneur creation always insufficient even when the planner is not allowed to remove entrepreneurial risks.

We relegate the formal mathematical proof to Appendix C and seek an explanation in the language of economics. We divide the explanation into two parts, (1) why the market equilibrium is constrained inefficient $\phi^m \neq \phi^{cp}$ and (2) what determines the direction of the market failure $\phi^m \lessgtr \phi^{cp}$.

3.1. Why is the market equilibrium constrained inefficient?

The intuition of the constrained inefficiency $\phi^m \neq \phi^{cp}$ can be understood by using the certainty equivalent. Note that the certainty equivalent of the workers is the wage itself $c^W = w$ since it is risk-free, while the certainty equivalent of the entrepreneurs c^E is defined by

$$u\left(c^E\right) = \mathbb{E}u(\pi(z, w)). \tag{5}$$

As a result of the indifference condition (4), the certainty equivalents are equated in the market equilibrium $c^E = c^W$. Accordingly, the marginal utilities evaluated at the certainty equivalents are also equated

$$u'\left(c^E\right) = u'\left(c^W\right). \tag{6}$$

This is true no matter whether there are entrepreneurial risks or not.

What the planner can do is to change the wage w by controlling the number of entrepreneurs ϕ. To understand how the planner improves upon the market equilibrium, suppose for simplicity that the number of workers and entrepreneurs are the same $\phi^m = \frac{1}{2}$. One can indeed generate such an equilibrium by varying the production technology.

Now, suppose that the planner increases the wage w marginally by 1 unit from the market equilibrium w^m. If there are no entrepreneurial risks, consumption and certainty equivalents are identical. The fact that the mass of workers equals to that of entrepreneurs implies that, when worker's consumption increases by 1 unit, entrepreneur's consumption decreases by exactly the same 1 unit $\Delta c^W = -\Delta c^E = 1$. Since the marginal utilities of the certainty equivalents are equated (6), the welfare gain from the workers $u'\left(c^W\right)\Delta c^W$ is exactly canceled out by the welfare loss of the entrepreneurs $u'\left(c^E\right)\Delta c^E$, ending up with 0 welfare gain in net

$$u'\left(c^E\right)\Delta c^E + u'\left(c^W\right)\Delta c^W = u'\left(c^W\right)\left(\Delta c^E + \Delta c^W\right) = 0.$$

This is why the market is constrained efficient when there are no entrepreneurial risks.

If there are entrepreneurial risks, however, the 1 unit increase in the worker's consumption $\Delta c^W = 1$ does not necessarily correspond to the 1 unit decrease in the entrepreneur's certainty equivalent $\Delta c^E \neq -1$, since the wage change might affect the distribution of the profit $\pi(z, w)$ and therefore alter both the expected profit and its risk premium. As a result, the utility differences might not cancel out

$$u'\left(c^E\right)\Delta c^E + u'\left(c^W\right)\Delta c^W = u'\left(c^W\right)\left(\Delta c^E + \Delta c^W\right) \neq 0.$$

Thus, the planner can find a welfare gain out of this redistribution. Note that the only difference from the no-risk case is whether the wage change affects the risk premium of the entrepreneur's consumption or not. Hence, the marginal change in the risk premium of the entrepreneur's consumption is a sufficient statistic of the constrained inefficiency.

We can formalize the argument as follows.

Proposition 3. *Suppose (1) (u, f) is continuously differentiable, strictly increasing, strictly concave, and satisfies the Inada condition and (2) the constrained efficient allocation is characterized by the first order condition $U'(\phi^{cp}) = 0$. Let the risk premium $R(w)$ of entrepreneurs be defined by*

$$\mathbb{E}u(\pi(z, w)) = u(\mathbb{E}\pi(z, w) - R(w)). \tag{7}$$

[1] An equivalent alternative formulation is

$$\left(\phi^{cp}, w^{cp}\right) = \arg\max_{\phi\in[0,1],w} \phi\mathbb{E}u(\pi(z, w)) + (1-\phi)u(w) \;\; s.t. \;\phi\mathbb{E}n(z, w) = 1-\phi.$$

Then,

1. *the market generates a constrained inefficient number of entrepreneurs $\phi^m \neq \phi^{cp}$ if and only if $R'(w^m) \neq 0$.*
2. *$U'(\phi^m)$ and $R'(w^m)$ have the opposite signs. Thus, if $R'(w^m) > 0\,(< 0)$, the planner can locally improve welfare by decreasing (increasing) entrepreneurs.*

Proof. The indifference condition (4) implies that the first-order condition of the constrained planner evaluated at the market equilibrium is

$$U'\left(\phi^m\right) = \left\{\phi^m \frac{d\mathbb{E}u\left(\pi\left(z, w^m\right)\right)}{dw} + \left(1-\phi^m\right) u'\left(w^m\right)\right\} w'\left(\phi^m\right). \tag{8}$$

To simplify this equation, note that the derivative of the definition of the risk premium $R(w)$ evaluated at the market equilibrium $w = w^m$ gives

$$\frac{d\mathbb{E}u\left(\pi\left(z, w^m\right)\right)}{dw} = u'\left(\mathbb{E}\pi\left(z, w^m\right) - R\left(w^m\right)\right) \times \left\{\frac{d\mathbb{E}\pi\left(z, w^m\right)}{dw} - R'\left(w^m\right)\right\}. \tag{9}$$

Also note that by the envelope theorem and market clearing condition

$$\frac{\partial \mathbb{E}\pi\left(z, w^m\right)}{\partial w} = -\mathbb{E}n\left(z, w^m\right) = -\frac{1-\phi^m}{\phi^m}. \tag{10}$$

Substituting Eqs. (9) and (10) into Eq. (8) and applying the indifference condition (4) lead to

$$U'\left(\phi^m\right) = -\phi^m u'\left(w^m\right) w'\left(\phi^m\right) R'\left(w^m\right). \tag{11}$$

We know $U'(\phi^m) = 0$ is equivalent to $\phi^m = \phi^{cp}$. We also know the signs of each term, $\phi^m > 0$, $u'(w^m) > 0$, and

$$w'(\phi) = -\frac{1 + \mathbb{E}n(z, w)}{\phi \frac{d\mathbb{E}n(z,w)}{dw}} > 0. \tag{12}$$

Hence, the market generates a constrained inefficient number of entrepreneurs if and only if $R'(w^m) \neq 0$. □

Note that the mathematical proof is parallel to the intuition that we discussed before Proposition 3. Eq. (8) corresponds to the thought experiment of the marginal wage increase and Eq. (11) corresponds to the observation that how the wage change impacts the risk premium $R'(w^m)$ is a sufficient statistic for the constrained inefficiency $\phi^m \neq \phi^{cp}$. Assuming the concavity of U, $R'(w^m)$ is also a sufficient statistic of the direction of the inefficiency

$$\phi^m \lesseqgtr \phi^{cp} \Leftrightarrow R'\left(w^m\right) \lesseqgtr 0.$$

We note two observations. First, the argument in this subsection does not rely on any specific parametrization. As long as the first order conditions are sufficient to characterize both the market and planner's allocations, the same intuition holds for any fundamentals. Second, the aggregate output does not show up in Eq. (11), although one can show that the marginal increase in the number of entrepreneurs raises output. This is because the agents who change the occupation from workers to entrepreneurs need to be compensated by exactly the same amount as the marginal increase in output in order to be indifferent between the two occupations. Therefore, at the margin, the welfare gain from the increase in the number of entrepreneurs does not come from the output increase but comes solely from the risk premium reduction.

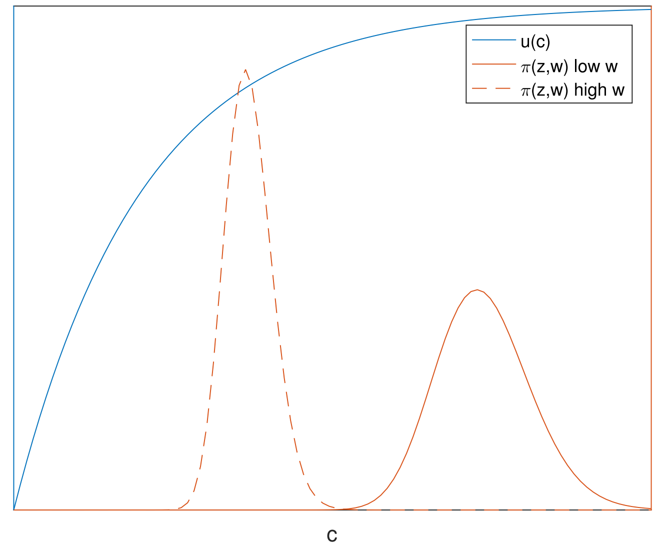

Fig. 1. Utility function and the distributions of the entrepreneurs' profit $\pi(z, w)$.

3.2. What determines the direction of the market failure?

The previous section discussed that the elasticity of the risk premium $R'(w^m)$ is a sufficient statistic for the sign of the market failure $\phi^m \gtrless \phi^{cp}$. A natural question is "what determines the sign of the elasticity of the risk premium $R'(w^m)$?"

To answer this question, suppose that the wage increases. As Fig. 1 shows, there are two forces that affect the risk premium $R(w)$.

On one hand, the distribution of the entrepreneur's consumption shifts to the left since the profit $\pi(z, w)$ is a decreasing function of the wage w. This shift moves the distribution to a more risk-averse region of the utility function (assuming u exhibits decreasing absolute risk aversion), so it raises the risk premium $R(w)$.

On the other hand, the variance of the profit goes down. Such a decline becomes salient if one takes the limit $w \to \infty$, in which case the profit goes to $\pi(z, w) \to 0$ for each productivity level z. This effect reduces the risk premium $R(w)$.

Therefore, the elasticity is determined by the relative strength of these two forces. As stated in the second statement of Proposition 2, under the standard parametrization, i.e., CRRA utility and CD production functions, the latter force always wins, i.e., $R'(w) < 0$ for all $w > 0$ including the market equilibrium wage w^m. However, this is not always the case as in the first statement. In fact, the proof of Proposition 2 in Appendix C.2 provides an example in which a wage increase raises the risk premium $R'(w^m) > 0$. Intuitively, such a scenario is possible if agents suddenly become less risk-averse when the consumption is above some threshold. Under such a utility function, the force that makes agents risk averse jumps up, but the force that reduces the variance of the profit π works smoothly. As a result, such preference justifies the reduction of wage and therefore the reduction of entrepreneurs $\phi^{cp} < \phi^m$. Another example that generates excessive entrepreneurs $\phi^{cp} < \phi^m$ uses financial frictions in the producer's problem and is presented in Appendix E.3.

4. Policy implications

The constrained planner can be interpreted as a government that can control the number of business licenses. In this case, the sufficient statistic summarizes what the government needs to know and the number of licenses is the policy instrument. Note that it is true that, if the government conducts a license lottery, all agents will prefer it to the competitive market, but it does not mean all agents will be satisfied with the results of the lottery since the indifference condition does not hold under the constrained efficient allocation. In other words, the constrained efficient level of entrepreneurship cannot be achieved by exogenously fixing the wage to the constrained efficient level, unlike in the literature that studies constrained efficiency using risky portfolio choice. Davila et al. (2012) and Toda (2015).

One can also interpret the constrained planner simply as a theoretical device to understand the market failure associated with the risk occupation choice. In this case, the analysis is pedagogically useful because it provides a clear intuition about the concept of constrained efficiency.

We prefer not, however, to explore the implementation of the constrained efficient allocation by some tax instrument as done in the literature. Davila et al. (2012), Toda (2015) and Davila and Korinek (2017) This is because, as Gottardi et al. (2015) point out, the tax rate that achieves the constrained efficient allocation may not coincide with the optimal tax rate that achieves the highest welfare level that the tax instrument can achieve. In other words, the analyses of the constrained efficiency and optimal taxation are two separate problems in general because the choice sets of the two problems are different. Specifically in the current model, if a tax can remove risks, it can achieve higher welfare than the constrained planner. Thus, implementation analysis does not seem to add much insight to the constrained efficiency analysis that is designed to reveal the nature of the market failure.

That being said, the framework of the competitive entrepreneurship does have an interesting tax policy application. For example, see Ando (2019) for an analysis of size-dependent firm regulation policies using optimal taxation technique.

5. Extensions

The analysis of constrained efficiency can be extended in several dimensions. We briefly discuss three examples in this section and relegate the details to Appendices.

One natural extension is heterogeneous productivity of entrepreneurs as Lucas (1978). More generally, we can introduce a signal s_i about the productivity z_i and assume agents make occupation choice based on the signal s_i. In such a heterogeneous-agent model, although it is straightforward to set up the constrained planner's problem, the conclusion is sensitive to Pareto weight. Appendix E.1 shows that, under the utilitarian welfare and standard parametrization, the competitive market generates insufficient entrepreneurs.

Another natural extension is the inter-temporal decision of capital accumulation. In Appendix E.2, we introduce capital accumulation a la Krebs (2003) and set up the constrained planner's problem as a deviation from the stationary distribution. We show that, under CRRA utility and CD production functions, the competitive market generates an insufficient number of entrepreneurs. Thus, the inter-temporal decision itself does not alter the intuition in the static model.

An interesting extension is financial frictions. In Appendix E.3, we show that, under severe financial frictions, the competitive market generates an excessive number of entrepreneurs. The idea is that financial frictions that prevent firms from expanding their employment size increase the number of firms because big firms cannot absorb the labor force so that the unemployed need to do businesses on their own. Appendix E.3 shows that the number of firms not only increases but also increases more than the constrained efficient level, and thus, the direction of constrained inefficiency becomes the opposite.

6. Concluding remarks

We have discussed the constrained efficiency of the competitive entrepreneurship model with risky occupation choice. In particular, we have highlighted two points: (1) the market can generate excessive entrepreneurs even when the only friction is entrepreneurial risks and agents are risk-averse and (2) the model allows a sharp economic intuition because the market equilibrium is characterized by an indifference condition instead of a marginal condition.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jmateco.2020.03.005.

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